WHAT IS CLAIMED IS:

1. A method to perform low-density parity-check code encoding of user data u of length N_u, by inserting parity data p of length N_p into output data c of length N in accordance with a parity matrix H such that $\mathbf{H} \bullet \mathbf{c} = 0$, comprising the steps of:

(a) receiving the user data of block length N_u;

(b) decomposing $\mathbf{H} \bullet \mathbf{c}$ into a first component $\mathbf{H_u} \bullet \mathbf{u}$ corresponding to the user data and a second component $\mathbf{H_p} \bullet \mathbf{p}$ corresponding to the parity data such that $\mathbf{H_u} \bullet \mathbf{u} + \mathbf{H_p} \bullet \mathbf{p} = 0$;

(c) calculating a vector $\underline{u} = \mathbf{H_u} \bullet \mathbf{u}$; and

(d) calculating $p = \mathbf{H_u}^{-1} \bullet \underline{u}$.

2. The method of Claim 1, wherein $\mathbf{H_u}$ comprises a N_p x N_u matrix and $\mathbf{H_p}$ comprises a N_p x N_p matrix.

3. The method of Claim 1, further comprising the step of:

(e) receiving address information,

wherein step (c) is performed in accordance with step(e).

4. The method of Claim 1, wherein step (c) comprises the step of:

(f) updating elements of $\underline{u}$ as follows:

$\underline{u}(i) = \underline{u}(i) \oplus$ bit.

5. The method of Claim 1, wherein step (d) comprises the step of:

(g) reducing a row weight of $\mathbf{H_u}^{-1}$ by representing $\mathbf{H_u}^{-1}$ as M1 * M2.

6. The method of Claim 1, wherein step (d) comprises the step of:

(g) reducing a row weight of $\mathbf{H_u}^{-1}$ by representing $\mathbf{H_u}^{-1}$ as $\prod_{i=1}^{5} M_i$.

7. The method of Claim 1, wherein step (c) is performed prior to step (d).

8. A low-density parity-check code encoder to encode user data u of length N_u, by inserting parity data p of length N_p into output data c of length N in accordance with a parity matrix H such that $\mathbf{H \bullet c} = 0$, comprising:

an input to input the user data of block length N_u;

an H c decomposer to decompose $\mathbf{H \bullet c}$ into a first component $\mathbf{H_u \bullet u}$ corresponding to the user data and a second component $\mathbf{H_p \bullet p}$ corresponding to the parity data such that $\mathbf{H_u \bullet u} + \mathbf{H_p \bullet p} = 0$;

a $\underline{u}$ calculator to calculate a vector $\underline{u} = \mathbf{H_u \bullet u}$; and

a $p = \underline{P}\ \underline{u}$ calculator to calculate $p = \mathbf{H_u}^{-1} \bullet \underline{u}$.

9. The encoder of Claim 8, wherein $\mathbf{H_u}$ comprises a N_p x N_u matrix and $\mathbf{H_p}$ comprises a N_p x N_p matrix.

10. The encoder of Claim 8, further comprising:

a second input to input address information,

wherein said $\underline{u}$ calculator calculates the vector $\underline{u} = \mathbf{H_u \bullet u}$ in accordance with said second input.

11. The encoder of Claim 8, wherein said $\underline{u}$ calculator updates elements of $\underline{u}$ as follows:

$\underline{u}(i) = \underline{u}(i) \oplus$ bit.

12. The encoder of Claim 8, wherein said $p = \underline{P}\ \underline{u}$ calculator reduces a row weight of $\mathbf{H_u}^{-1}$ by representing $\mathbf{H_u}^{-1}$ as M1 * M2.

13. The encoder of Claim 8, wherein said p=P u calculator reduces a row weight of $\mathbf{H_u}^{-1}$ representing $\mathbf{H_u}^{-1}$ as $\prod_{i=1}^{s} M_i$.

14. The encoder of Claim 8, wherein said u calculator calculates the vector $\underline{u} = \mathbf{H_u} \bullet \mathbf{u}$ prior to said p=P u calculator calculating $p= \mathbf{H_u}^{-1} \bullet \underline{u}$.

15. A computer program to perform low-density parity-check code encoding of user data u of length N_u, by inserting parity data p of length N_p into output data c of length N in accordance with a parity matrix H such that $\mathbf{H} \bullet \mathbf{c} = 0$, comprising the steps of:

(a) receiving the user data of block length N_u;

(b) decomposing $\mathbf{H} \bullet \mathbf{c}$ into a first component $\mathbf{H_u} \bullet \mathbf{u}$ corresponding to the user data and a second component $\mathbf{H_p} \bullet \mathbf{p}$ corresponding to the parity data such that $\mathbf{H_u} \bullet \mathbf{u} + \mathbf{H_p} \bullet \mathbf{p} = 0$;

(c) calculating a vector $\underline{u} = \mathbf{H_u} \bullet \mathbf{u}$; and

(d) calculating $p= \mathbf{H_u}^{-1} \bullet \underline{u}$.

16. The computer program of Claim 15, wherein $\mathbf{H_u}$ comprises a N_p x N_u matrix and $\mathbf{H_p}$ comprises a N_p x N_p matrix.

17. The computer program of Claim 15, further comprising the step of:

(e) receiving address information,

wherein step (c) is performed in accordance with step(e).

18. The computer program of Claim 15, wherein step (c) comprises the step of:

(g) updating elements of u as follows:

$\underline{u}(i)=\underline{u}(i) \oplus$ bit.

19. The computer program of Claim 15, wherein step (d) comprises the step of:

(g) reducing a row weight of $\mathbf{H_u}^{-1}$ by representing $\mathbf{H_u}^{-1}$ as M1 * M2.

20. The computer program of Claim 15, wherein step (d) comprises the step of:

(g) reducing a row weight of $\mathbf{H_u}^{-1}$ by representing $\mathbf{H_u}^{-1}$ as $\prod_{i=1}^{s} M_i$.

21. The computer program of Claim 15, wherein step (c) is performed prior to step (d).

22. A data transmission system for transmitting user data to and receiving data from a communication channel, comprising:

a low-density parity-check code encoder to encode user data u of length N_u, by inserting parity data p of length N_p into output data c of length N in accordance with a parity matrix H such that $\mathbf{H \bullet c} = 0$, comprising:

an input to input the user data of block length N_u;

an H c decomposer to decompose $\mathbf{H \bullet c}$ into a first component $\mathbf{H_u \bullet u}$ corresponding to the user data and a second component $\mathbf{H_p \bullet p}$ corresponding to the parity data such that $\mathbf{H_u \bullet u} + \mathbf{H_p \bullet p} = 0$;

a $\underline{u}$ calculator to calculate a vector $\underline{u} = \mathbf{H_u \bullet u}$; and

a $p = \underline{P}\ \underline{u}$ calculator to calculate $p = \mathbf{H_u}^{-1} \bullet \underline{u}$;

a transmitter to transmit an output of said low-density parity-check code encoder to the communication channel;

a soft channel decoder to decode data from the communication channel; and

a soft low-density parity-check code decoder to decode data decoded by said soft channel decoder.

23. The system of Claim 22, wherein $\mathbf{H_u}$ comprises a N_p x N_u matrix and $\mathbf{H_p}$ comprises a N_p x N_p matrix.

24. The system of Claim 22, further comprising:

an address generator to generate address information in accordance with the user data;

second input means for inputting address information,

a second input to input address information,

wherein said $\underline{u}$ calculator calculates the vector $\underline{u} = \mathbf{H_u \bullet u}$ in accordance with said second input.

25. The system of Claim 22, wherein said $\underline{u}$ calculator updates elements of $\underline{u}$ as follows:

$\underline{u}(i)=\underline{u}(i) \oplus$ bit.

26. The system of Claim 22, wherein said $p=\underline{P}\ \underline{u}$ calculator reduces a row weight of $\mathbf{H_u^{-1}}$ by representing $\mathbf{H_u^{-1}}$ as M1 * M2.

27. The system of Claim 22, wherein said $p=\underline{P}\ \underline{u}$ calculator reduces a row weight of $\mathbf{H_u^{-1}}$ representing $\mathbf{H_u^{-1}}$ as $\prod_{i=1}^{s} M_i$.

28. The system of Claim 22, wherein said $\underline{u}$ calculator calculates the vector $\underline{u} = \mathbf{H_u \bullet u}$ prior to said $p=\underline{P}\ \underline{u}$ calculator calculating $p= \mathbf{H_u^{-1}} \bullet \underline{u}$.

29. A low-density parity-check code encoder to encode user data u of length N_u, by inserting parity data p of length N_p into output data c of length N in accordance with a parity matrix H such that $\mathbf{H \bullet c} = 0$, comprising:

input means for inputting the user data of block length N_u;

H c decomposer means for decomposing $\mathbf{H \bullet c}$ into a first component $\mathbf{H_u \bullet u}$ corresponding to the user data and a second component $\mathbf{H_p \bullet p}$ corresponding to the parity data such that $\mathbf{H_u \bullet u} + \mathbf{H_p \bullet p}=0$;

$\underline{u}$ calculating means for calculating a vector $\underline{u} = \mathbf{H_u} \bullet \mathbf{u}$; and

$p=\underline{P}\ \underline{u}$ calculating means for calculating $p= \mathbf{H_u}^{-1} \bullet \underline{u}$.

30. The encoder of Claim 29, wherein $\mathbf{H_u}$ comprises a N_p x N_u matrix and $\mathbf{H_p}$ comprises a N_p x N_p matrix.

31. The encoder of Claim 29, further comprising:

second input means for inputting address information,

wherein said $\underline{u}$ calculating means calculates the vector $\underline{u} = \mathbf{H_u} \bullet \mathbf{u}$ in accordance with said second input means.

32. The encoder of Claim 29, wherein said $\underline{u}$ calculating means updates elements of $\underline{u}$ as follows:

$\underline{u}(i)=\underline{u}(i) \oplus$ bit.

33. The encoder of Claim 29, wherein said $p=\underline{P}\ \underline{u}$ calculating means reduces a row weight of $\mathbf{H_u}^{-1}$ by representing $\mathbf{H_u}^{-1}$ as M1 * M2.

34. The encoder of Claim 29, wherein said $p=\underline{P}\ \underline{u}$ calculating means reduces a row weight of $\mathbf{H_u}^{-1}$ representing $\mathbf{H_u}^{-1}$ as $\prod_{i=1}^{s} M_i$.

35. The encoder of Claim 29, wherein said $\underline{u}$ calculating means calculates the vector $\underline{u} = \mathbf{H_u} \bullet \mathbf{u}$ prior to said $p=\underline{P}\ \underline{u}$ calculating means calculating $p= \mathbf{H_u}^{-1} \bullet \underline{u}$.

36. A data transmission system for transmitting user data to and receiving data from a communication channel, comprising:

low-density parity-check code encoding means to encode user data u of length N_u, by inserting parity data p of length N_p into output data c of length N in accordance with a parity matrix H such that $\mathbf{H} \bullet \mathbf{c} = 0$, comprising:

input means for inputting the user data of block length N_u;

H c decomposer means for decomposing $\mathbf{H \bullet c}$ into a first component $\mathbf{H_u \bullet u}$ corresponding to the user data and a second component $\mathbf{H_p \bullet p}$ corresponding to the parity data such that $\mathbf{H_u \bullet u + H_p \bullet p}=0$;

$\underline{u}$ calculating means for calculating a vector $\underline{u} = \mathbf{H_u \bullet u}$; and

$p=\underline{P}\ \underline{u}$ calculating means for calculating $p= \mathbf{H_u^{-1}} \bullet \underline{u}$;

transmitting means for transmitting an output of said low-density parity-check code encoding means to the communication channel;

soft channel decoding means for decoding data from the communication channel; and

soft low-density parity-check code decoding means for decoding data decoded by said soft channel decoding means.

37. The system of Claim 36,, wherein $\mathbf{H_u}$ comprises a N_p x N_u matrix and $\mathbf{H_p}$ comprises a N_p x N_p matrix.

38. The system of Claim 36,, further comprising:

address generator means for generating address information in accordance with the user data;

second input means for inputting the address information,

wherein said $\underline{u}$ calculating means calculates the vector $\underline{u} = \mathbf{H_u \bullet u}$ in accordance with said second input means.

39. The system of Claim 36,, wherein said $\underline{u}$ calculating means updates elements of $\underline{u}$ as follows:

$\underline{u}(i)=\underline{u}(i) \oplus$ bit.

40. The system of Claim 36,, wherein said $p=\underline{P}\ \underline{u}$ calculating means reduces a row weight of $\mathbf{H_u}^{-1}$ by representing $\mathbf{H_u}^{-1}$ as M1 * M2.

41. The system of Claim 36,, wherein said $p=\underline{P}\ \underline{u}$ calculating means reduces a row weight of $\mathbf{H_u}^{-1}$ representing $\mathbf{H_u}^{-1}$ as $\prod_{i=1}^{s} M_i$.

42. The system of Claim 36,, wherein said $\underline{u}$ calculating means calculates the vector $\underline{u} = \mathbf{H_u} \bullet \mathbf{u}$ prior to said $p=\underline{P}\ \underline{u}$ calculating means calculating $p= \mathbf{H_u}^{-1} \bullet \underline{u}$.